(12) AUSTRALIAN PATENT ABSTRACT
(19) AU (11) AU-A-56568/86

(54) PRODUCING HARD FACING COMPOSITION

(75) ROMAN FRANCIS ARNOLDY

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(74) SA

(57) Claim

1. A bulkwelding method for producing an iron-based alloy having high resistance to abrasion suitable for use as a hardfacing material, comprising forming the alloy on a workpiece by arc welding with a consumable iron or steel electrode in the presence of granular metal filler material and feeding the granular metal filler material to the workpiece in a controlled ratio to the feed rate of the electrode, the composition of the granular metal filler material being selected to provide in the iron-based alloy so formed a chromium content of 12 to 25% by weight, a carbon content of 4 to 4.9% by weight and at least 38% by volume of primary carbides of iron and chromium while maintaining the feed ratio of granular metal filler material : electrode at not more than 1.6 : 1.

7. A method according to any one of the preceding claims wherein the granular metal filler material is an iron-based powder containing, by weight, 46 to 50% chromium, 8 to 8.5% combined carbon, 5 to 5.5% manganese and less than 1% silicon.

COMMONWEALTH OF AUSTRALIA

Patents Act 1952

P/00/001
Form 1
Regulation 9

APPLICATION FOR A STANDARD PATENT OR A STANDARD PATENT OF ADDITION

LODGED AT SUB-OFFICE
21 APR 1986
Melbourne

Insert full name(s) of applicant(s)

(71) I/We ROMAN FRANCIS ARNOLDY

Insert address(es) of applicant(s)

of 225 Millbrook, Houston, Texas 77024, United States of America

Insert title of invention

(54) hereby apply for the grant of a ☒ standard patent ☐ patent of addition for an invention entitled

METHOD FOR PRODUCING A HARDFACING ALLOY COMPOSITION

Tick appropriate box)

which is described in the accompanying ☐ provisional ☒ complete specification.

Insert name of actual inventor

(72) The actual inventor(s) of the said invention is/are ROMAN FRANCIS ARNOLDY

Insert address for service of notices in Australia

(74) My/Our address for service is SANDERCOCK, SMITH & BEADLE, 207 Riversdale Road, (P.O. Box 410) Hawthorn, Victoria, 3122 Attorney Code SA

for Convention case only)

(ONLY TO BE USED IN THE CASE OF A CONVENTION APPLICATION)

Details of basic application(s) —

NUMBER	COUNTRY	DATE OF APPLICATION	ISO Code
735001	United States of America	17 May 1985	US

Insert day, month and year form signed

Dated this 21st day of April 19 86

Signature of applicant or Australian attorney

Charles Sandercock
(Signature)
SANDERCOCK, SMITH & BEADLE

TO

THE COMMISSIONER OF PATENTS

This form must be accompanied by either a provisional specification (Form 9 and true copy) or by a complete specification (Form 10 and true copy).

Form 6

AUSTRALIA

Patents Act 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention application made for a patent for an invention entitled

Method for producing a hardfacing alloy composition

Roman Francis Arnoldy

225 Millbrook, Houston, Texas 77024, USA

do solemnly and sincerely declare as follows:-

1. I am the applicant for the patent

or, in the case of an application by a body corporate,

1. ~~I am authorized by the applicant for the patent to make this declaration on its behalf.~~

2. The basic application as defined by section 141 of the Act was made in USA on the 17th day of May in 85 by me

3. I am the actual inventor of the invention referred to in the basic application

or, where a person other than the inventor is the applicant,

3 N/A

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application

or, where a request is made under section 141A of the Patents Act 1952, for an earlier application made in a Convention country to be disregarded:

4.-(1.) ~~I am the actual inventor of the invention and the facts upon which I am entitled to make the application are as follows:-~~

(2.) ~~As~~

(3.) ~~[Here set out in succeeding sub-paragraphs the facts that show that section 141A is applicable.]~~

~~I am informed and believe that the facts upon which I am entitled to make the application are as follows:-~~

Declared at Houston, Texas this 5 day of December 1985

Roman Francis Arnoldy

(Signature of Declarant)

TO:

THE COMMISSIONER OF PATENTS.

(IMPORTANT - Cross out inapplicable words in above Form.)

Form 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

LODGED AT SUB-OFFICE
21 APR 1986
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Application Number:
Lodged:

56568/86

Complete Specification—Lodged:
Accepted:
Lapsed:
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Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: ROMAN FRANCIS ARNOLDY

Address of Applicant: 225 Millbrook, Houston, Texas 77024, United States of America

Actual Inventor: ROMAN FRANCIS ARNOLDY

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HAWTHORN. VIC. 3122.

Complete Specification for the invention entitled:

METHOD FOR PRODUCING A HARDFACING ALLOY COMPOSITION

The following statement is a full description of this invention, including the best method of performing it known to me:—*

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* Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 165 mm in width, on tough white paper of good quality and it is to be inserted inside this form.

1 :86/77—4 Printed by C. J. Thompson, Acting Commonwealth Government Printer, Canberra

This invention relates to the use of the bulkwelding method for producing desirable hardfacing alloy deposits and, more particularly, to the use of bulkwelding to produce a hardfacing material having a high content of primary iron-chromium-carbides ($(Cr-Fe)_7 C_3$) identified hereafter as $M_7 C_3$.

The use of iron-chromium-carbon hardfacings as applied by fusion welding processes is old and well-known art. These hardfacings provide inexpensive efficient resistance to abrasion because of a microstructure which contains one or more combinations of chromium and iron carbides. There are a variety of these carbides but the ones with the best abrasion resistance are of the $M_7 C_3$ type, called "primary carbides". The "M" represents a mixture of iron and chromium which can vary, but which are generally present as about two parts chromium to one part iron, by weight. The primary carbides are dispersed in a reticulated form in a matrix of other carbides and filler metals. The more primary carbides which are present in the resulting microstructure, the more resistance to abrasion the coating exhibits.

A typical 3.2 mm (1/8 inch) hardfacing layer produced by known bulkwelding techniques contains at least about 30% chromium by weight, about 62% iron, about 4½% carbon and has about 35% primary carbides by volume.

Bulkwelding is a process which employs the controlled addition of powdered metal filler materials to automatic arc welding. In the process, granulated

alloy metal powder is fed to the workpiece just ahead of an iron or steel electrode which is oscillated for the production of hardfacings. The electrode is usually oscillated in a 38mm (1½ inch) arc, transverse to the direction of the bead formed in the production of overlays and hardfacings. The amount of granular powder fed to the workpiece is precisely dispensed by a controlled electronic metering system in a precise ratio to the amount of electrode being fed. The chemistry of the weld deposit is dependent upon the granular metal filler materials, the consumable wire electrode, the dilution from the base material of the workpiece. To produce the typical alloy described above, the welding ratio (the weight ratio of granular powder to the weight of electrode) is about 1.5 parts powder to about 1 part of the iron or steel electrode wire.

Typical substrates to which the hardfacing deposit is applied are steel workpieces for use in high wear environments, frequently in the form of steel plate as industrial components such as work rolls, dies and punches.

Bulkwelding processes are disclosed in Applicant's prior U.S. Patent Nos. 3,076,888; 3,172,991; 3,260,834; 3,264,445; 3,296,408; 4,237,362; and 4,493,963.

Increasing the ratio of granular metal filler material to electrode wire consumed, in order to increase the content of the more abrasion resistant carbides in the hardfacing deposit, suffers the disadvantages that the technique becomes more difficult to use, and gives frequent defects in the weld deposit.

It has now been discovered that certain iron-chromium-carbon alloys of controlled chemistry may be produced with bulkwelding which have enhanced

amounts of primary carbides and reduced amounts of the less abrasion resistant carbides and other alloy materials, without increasing the welding ratio. By selecting a suitable analysis range, the input materials have sufficient chromium and carbon to produce the desired primary carbides while containing a minimum of other material. The alloy produced is a superior hardfacing material and can be used in environments of severe abrasion and from ambient to high temperatures, for example 650°C (1200°F).

It is, therefore, an object of the present invention to provide a method for using bulkwelding to produce an alloy with superior abrasion resistance characteristics.

Another object of the present invention is the provision of such a method to produce an alloy having less chromium, more carbon and yet significantly more primary carbides.

An important object of the present invention is the provision of high primary carbide alloys by bulkwelding without having to increase the ratio of granular welding material to wire electrode.

In accordance with the invention, a bulkwelding method for producing an iron-based alloy having high resistance to abrasion suitable for use as a hardfacing material, comprising forming the alloy on a workpiece by arc welding with a consumable iron or steel electrode in the presence of granular metal filler material and feeding the granular metal filler material to the workpiece in a controlled ratio to the feed rate of the electrode, is characterised by the composition of the granular metal filler material being selected to provide in the iron-based alloy so formed a chromium content of 12 to 25% by weight, a carbon content of 4 to 4.9% by weight and at least 38% by

volume of primary carbides of iron and chromium while maintaining the feed ratio of granular metal filler material : electrode at not more than 1.6 : 1.

In the preferred embodiments of the present invention, the filler powder charge for the bulkwelding operation may contain the following, by weight:

Chromium	about 46 to about 50%
Combined Carbon	about 8 to about 8.50%
Manganese	about 5 to about 5.50%
Silicon	less than about 1.00%
Molybdenum	optional, preferably about .5 to about 1.00%
Iron and incidental impurities	Balance

Other elements that may be present in the filler powder include niobium, titanium, tungsten, vanadium and boron.

The chromium is normally supplied in the form of ferrochromium of an analysis suitable to give the above percentage. The carbon is suitably supplied as a part of the ferrochrome by selecting a ferrochrome of the appropriate carbon content. Manganese is typically supplied as standard ferro manganese. Silicon is indigenous to the ferrochrome and its content percentage should be minimized. Molybdenum is not required to produce the basic alloy desired but is used in the presently preferred embodiments to give improved carbide performance.

The following examples further illustrate the invention, using a granular metal filler material of the preferred composition set out above.

The bulkwelding equipment is set so that about 1.5 weights of powder are fed for each weight of electrode. Oscillation of the electrode is preferably set at 35 mm (1 3/8 inch) so as to give a 38 mm (1½

inch) wide bead and allow consumption of the powder used. If the powder-to-electrode ratio exceeded about 1.6 to 1, the greater amount of powder would require a wider oscillation width in order to consume the powder. Also, the higher quantity of powder would cause erratic welding action and increase the tendency for defects to occur in the weld deposit.

In the sub-arc mode, the increased bead width would be undesirable since it causes the cracks formed in cooling to become too large for quality hardfacing. Thus, the maintenance of the 1.5/1 welding ratio is preferred.

Upon completion of the deposition, examination of the weld deposit discloses that the deposit has approximately 45% primary M_7C_3 carbides compared with 33-37% in the alloys made previously by bulkwelding.

Chemical analysis of a typical deposit according to this invention is as follows:

Chromium	about 12% to about 25% (about 23% preferred)
Carbon	about 4% to about 4.9% (about 4.7% preferred)
Manganese	about .5% to about 8% (about 3% preferred)
Silicon	less than about 1% by weight)
Iron	Balance

The typical alloy has a primary carbide content of about 38% to about 45% by volume, an increase of as much as 28% over alloys produced by prior art bulkwelding processes discussed above. For all the preferred embodiments, the powder-to-wire ratio can be maintained at about 1½ to 1. As desired, amounts of various other elements can be added to the weld

material to achieve specific results. Elements such as niobium, molybdenum, titanium, tungsten, vanadium or boron are examples of these. It is preferred that these elements be present combined as no more than about 3% by weight.

In conclusion, therefore, it is seen that the present invention and the embodiments disclosed herein are well adapted to carry out the objectives and obtain the ends set forth at the outset.

The claims form part of the disclosure of this specification.

CLAIMS

The claims defining the invention are as follows:

1. A bulkwelding method for producing an iron-based alloy having high resistance to abrasion suitable for use as a hardfacing material, comprising forming the alloy on a workpiece by arc welding with a consumable iron or steel electrode in the presence of granular metal filler material and feeding the granular metal filler material to the workpiece in a controlled ratio to the feed rate of the electrode, the composition of the granular metal filler material being selected to provide in the iron-based alloy so formed a chromium content of 12 to 25% by weight, a carbon content of 4 to 4.9% by weight and at least 38% by volume of primary carbides of iron and chromium while maintaining the feed ratio of granular metal filler material : electrode at not more than 1.6 : 1.

2. A method according to Claim 1, wherein the iron-based alloy formed contains up to 8% by weight manganese and not more than 3% by weight in total of niobium, molybdenum, titanium, tungsten, vanadium and boron.

3. A method according to Claim 1 wherein the composition of the granular metal filler material is selected to provide in the iron-based alloy formed a chromium content of 12 to 25% by weight, a carbon content of 4 to 4.8% by weight, a manganese content of 0.5 to 8% by weight and 38 to 45% by volume of primary carbides, the alloy having high resistance to abrasion at temperatures from ambient to 650°C (1200°F).

4. A method according to Claim 3 wherein the iron-based alloy formed contains not more than 3% by weight in total of niobium, molybdenum, titanium, tungsten, vanadium and boron.

5. A method according to any one of the preceding claims wherein the iron-based alloy formed contains about 3% by weight of manganese.

6. A method according to any one of the preceding claims wherein the iron-based alloy formed contains not more than 1% by weight of silicon.

7. A method according to any one of the preceding claims wherein the granular metal filler material is an iron-based powder containing, by weight, 46 to 50% chromium, 6 to 8.5% combined carbon, 5 to 5.5% manganese and less than 1% silicon.

8. A method according to Claim 7 wherein the iron-based powder further contains 0.5 to 1% by weight molybdenum.

9. A method according to Claim 7 or Claim 8 wherein the iron-based powder further contains at least one of niobium, titanium, tungsten, vanadium and boron.

10. A method according to any one of Claims 7, 8 and 9 wherein the balance of the composition of the iron-based powder is iron and incidental impurities.

11. A bulkwelding method for producing an iron-based alloy having high resistance to abrasion suitable for use as a hardfacing material, substantially as herein described with particular reference to the examples.

5. A method according to any one of the preceding claims wherein the iron-based alloy formed contains about 3% by weight of manganese.

6. A method according to any one of the preceding claims wherein the iron-based alloy formed contains not more than 1% by weight of silicon.

7. A method according to any one of the preceding claims wherein the granular metal filler material is an iron-based powder containing, by weight, 46 to 50% chromium, 8 to 8.5% combined carbon, 5 to 5.5% manganese and less than 1% silicon.

8. A method according to Claim 7 wherein the iron-based powder further contains 0.5 to 1% by weight molybdenum.

9. A method according to Claim 7 or Claim 8 wherein the iron-based powder further contains at least one of niobium, titanium, tungsten, vanadium and boron.

10. A method according to any one of Claims 7, 8 and 9 wherein the balance of the composition of the iron-based powder is iron and incidental impurities.

11. A bulkwelding method for producing an iron-based alloy having high resistance to abrasion suitable for use as a hardfacing material, substantially as herein described with particular reference to the examples.

12. A bulkwelding method substantially as hereinbefore described with reference to any one of the Examples.

13. An alloy produced by the method of any preceding claim.

14. The articles, things, parts, elements, steps, features, methods, processes, compounds and compositions referred to or indicated in the specification and/or claims of the application individually or collectively, and any and all combinations of any two or more of such.

DATED THIS 17th DAY OF April 1986.

ROMAN FRANCIS ARNOLDY

By his Patent Attorneys:

SANDERCOCK, SMITH & BEADLE

Fellows Institute of Patent Attorneys of Australia.